

Why Math



While in the elementary mathematics master's program at the University of North Carolina at Chapel Hill, I became interested in the use of Web logs (blogs) as a tool to encourage online discussions. During a summer course titled Reinventing Teaching, my professor used blogs to start or continue discussions concerning various course topics. Intrigued by the depth of my classmates' responses and the freedom of thought that the process gave me as a participant, I wondered how this technological tool could be used in a third-grade classroom. I decided to implement blogs across the curriculum in almost every subject.

Classroom Information and Demographics

In January 2006, when this study using mathematics blogs began, my eight- to nine-year-old third graders had used blogs in other subjects since the beginning of the school year. They were engaging in online discussions regarding science units, antibullying lessons, book sharing for literacy centers, and various social studies topics. They were expressing their ideas and responding to their classmates' ideas in constructive, well-considered ways.

The twenty-two students in the class possessed a diverse range of academic ability and technologi-

cal fluency. The class was evenly divided in gender. Three students were African American, and one was Hispanic. Five students were English Language Learners from South Korea and Japan; four of the five had lived in the United States for fewer than six months.

Over the academic year, I engaged in developing and implementing an action research project to study the impact of blogs on the quality of mathematical discussions. I was particularly interested in how blogs facilitate productive discussion about solutions to multistep mathematics problems. A major part of my focus was my third graders' use of metacognitive thinking skills. In my research, *metacognition* is defined as the ability of students to explain the steps of their thinking processes through written words. This includes using appropriate mathematics vocabulary, describing computations, and expressing reasoning for their strategies. For the purposes of this third-grade class, blogs served as online forums where students were permitted to

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post their mathematical ideas and solutions. The postings were responses to high-cognitive demand questions and open-ended story problems posed by me as the teacher. Students responded to their classmates' ideas, and these responses essentially became the online discussion (see **fig. 1**).

Verbal interactions are recognized as a critical form of interaction between students when working toward knowledge construction (Palincsar 1986). Because blogs are primarily written interactions, I was curious to observe how my students would construct knowledge through an online mathematics classroom. As I planned for the new school year, I wondered how the use of online discussions could encourage face-to-face mathematics discussions in an elementary classroom. The following questions guided my instruction:

- How do blogs encourage discussions about mathematics?

- Do blogs enhance mathematics learning? If so, how and why?
- How do mathematics blogs encourage metacognitive thinking?

Facilitating Math Blogs

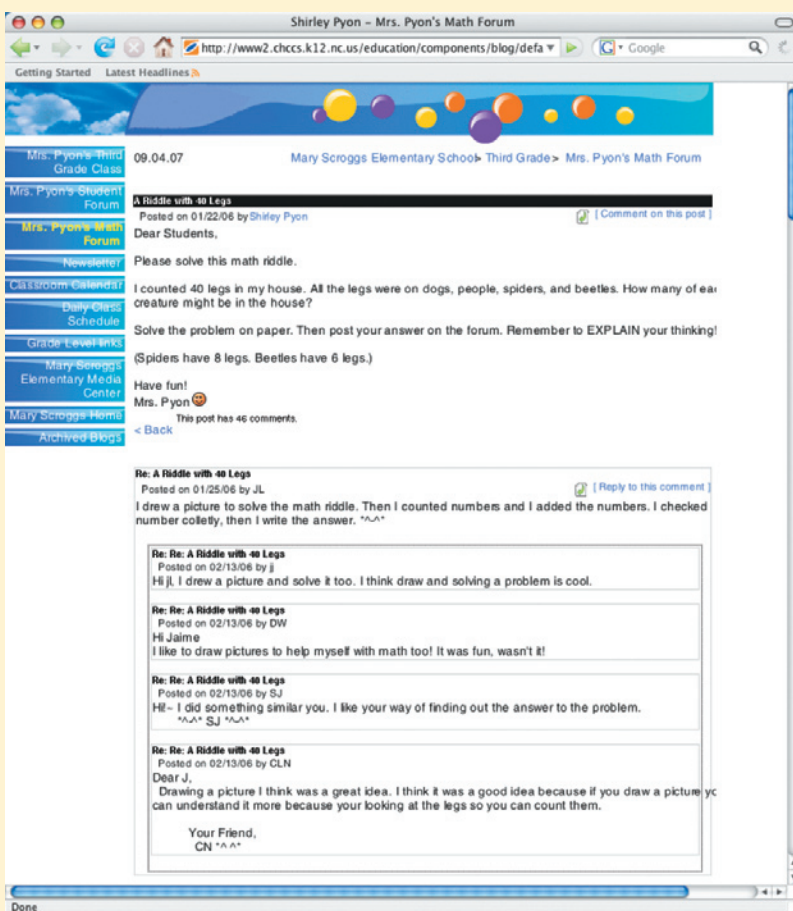
My primary focus during my students' work on the online discussions was the use of Math Forum, the mathematics blogging section of our online discussion platform. (All the students' other curriculum areas are called Student Forum.) On Math Forum, I posted a multistep mathematics story problem online every other week for two months. I gave the students a paper copy of the problem to solve, and then they could post their solutions on the forum, explaining how they found the solution so that peers and teachers could understand their thinking process. After all the students had made an online posting, they went back to read their classmates' ideas and posted responses to a minimum of three solutions. The students were not required to explain their thinking in their responses to the other students' work.

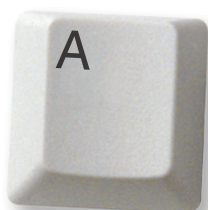
My Discovery

As my students became adept bloggers, an online learning community developed. The students were eager to post their solution methods online and always anticipated their peers' responses. The warm, inviting tone of their responses encouraged enthusiasm, more student participation, and a culture of support. The students frequently included affirming remarks about their peers (something they did not always do in the regular classroom environment). Face to face in small group discussions, students rarely offer each other encouraging remarks, especially in cross-gender interactions. However, on Math Forum, the positive comments occurred frequently in same-gender and cross-gender interactions. During a whole-group discussion about Math Forum, I asked the students why more compliments occurred on the blogs than during discussion time. The consensus in the third-grade social world was that complimenting peers on their excellent mathematics thinking is generally not the norm: "It's hard to say nice things to people's faces." "It's hard to go up to someone and tell them 'good job.'" "Kids might say 'ew' if you make a nice comment." A few students stated that they "felt more confident on the computer" and that "the computer makes it easier to say nice things."

Figure 1

A sample blog page





Despite the facts that blogs are electronic and that computer work can be impersonal, my third graders succeeded in creating a friendly virtual classroom.

I discovered that Math Forum did indeed enhance mathematics learning by encouraging metacognitive thinking. According to Garner and Alexander (1989), metacognitive knowledge often consists of several interrelated components: knowledge of one's own cognition, knowledge about the specific cognitive demands of varied learning tasks, and procedural knowledge of when and where to use acquired strategies. My students were required to explain their steps, calculations, and strategies on their first postings. Metacognitive thought surfaced in their initial responses primarily as the knowledge of their own cognition, the mental process of being aware of their thinking. However, the most compelling evidence of metacognition occurred in the students' exchange of ideas when explanations were *not* required. For example, during an integrated study unit on fairy tales, I gave students the following height problem:

Fairy tale characters Ted, Sue, Lou, Beth, and Ray are a combined height of thirty-one feet. Sue and Beth are twins and are the same height. They are taller than Ray. Lou is shorter than the twins but taller than Ray and Ted. Ray is taller than Ted. What is each character's possible height? What are their heights in inches? In yards? Explain your thinking. How did you get your answer?

CM (the initials represent pseudonyms of my students) wrote this as his initial response:

This is how I solved the problem. First, I read the problem about three times. Then, I wrote down the names, tallest to shortest. The next thing I did was guess what the numbers might be. I kept doing that until I got something close to 30. I wrote something that equals 1 foot. I came up with Ted was 5 feet (1 yard 24 inches, or 60 inches.) Ray was 5 feet 11 inches (1 yard 35 inches, or 71 inches). Lou was 6 feet 1 inch (2 yards 1 inch, or 73 inches.) Sue and Beth were both 7 feet (2 yards 12 inches, or 84 inches).

In his initial entry, CM illustrates his metacognitive thinking as he explains the steps he took to complete the task. He is aware of his own thinking process and displays his understanding of procedural knowledge by explaining how he guessed until he got a number close to thirty.

Another student, GG, initially responded this way:

I thought this problem was hard at first, but I got the hang of it. I used the method of "guess and check" for this problem. I also used the information given in the problem to help me guess. These heights are the ones I got in the problem: Sue and Beth's heights were 7 feet tall, or 84 inches, or 2 yards and 1 foot, the highest I used. They were the tallest, so I made them tall. Lou's height was 6 feet and 10 inches, or 82 inches, or 2 yards and 10 inches, in the middle. In the story, Lou was described as the middle. Ray, the next shortest person, was 5 feet and 2 inches, or 62 inches, or 1 yard and 2 feet and 2 inches. Ted was 5 feet, or 60 inches, or 1 yard and 2 feet.

GG responded to CM:

I did "guess and check," too! I think it is very effective, don't you? First, I learned what the order of the heights was, so I wouldn't be totally wrong. Then, I started to guess what the heights might be. At one time, I got to my final answer. My final answers were that Sue was 7 feet tall, and Beth was the same. Lou was 6 1/2 feet tall. Ray was 5 1/2 feet tall. Ted, the shortest, was 5 feet tall. When you add it all up, the sum is 31 feet! (the combined height)

In this exchange, GG demonstrated metacognition during her initial response by explaining the steps of her thinking. She also displayed her understanding of procedural knowledge and its appropriate use by naming the strategy she used and identifying it as similar to CM's.

This online dialogue, although simple, does not often occur as clearly in a face-to-face discussion. On blogs, students have to write responses rather than verbalize them aloud, so they are forced to think about their own solution strategies as well as their peers' solutions. As a result, metacognitive thinking occurred frequently during students' exchanges throughout the mathematics blogs.

Math Blogs and Classroom Instruction

Because my online classroom allowed students the opportunity to express their ideas without interruption and without fear of speaking publicly in front of their peers, students began to place value



on their peers' ideas, suggestions, and insights. One student commented, "On the computers, we get to see what everyone did to get their answers; but in class, we don't get to see that."

For my five English Language Learners (ELL), who are especially withdrawn during whole-group discussions, the blogs were the ideal tool for expressing their mathematical finds. I gave them as much time as they needed to complete the forum questions, and they did not have to worry about how their accents sounded when they spoke aloud. Witnessing their increasing boldness, the development in their literacy skills, and the growing expression of their thought processes encouraged me. Their responses on the blogs expanded from phrases to sentences, so the postings were an excellent record of their growth.

My Korean ELL students were also dealing with the cultural implications of learning in the American school environment. They frequently commented on how different the learning atmosphere is in the United States and how they were not given the opportunity to express their feelings and thoughts about various topics in their former schools. From my conversations with their parents, I know that my ELL students' schooling experiences in Korea—especially in mathematics—placed emphasis on speedy processes and correct answers; not a great deal of value was placed on diversity in thinking and unique solution strategies. My ELL students and parents had a positive reaction to the online discussions. Four of the five stu-

dents responded positively on the student surveys on the mathematics blogs.

My findings suggested that blogs are an effective communications and learning tool for all learners. Even more important, Math Forum nurtures higher-level thinking skills for all students. Bloom's taxonomy (Bloom et al. 1956; Boone et al. 2005) includes six increasingly higher-order thinking strategies: knowledge, comprehension, application, analysis, synthesis, and evaluation. Through the mathematics blogs, my students showed evidence of *knowledge* when they solved their story problems correctly and thus showed mastery of a mathematical idea. *Comprehension* occurred when they grasped the meaning of their peers' solutions and understood the information given. Some students demonstrated *application* when they used the information presented by their classmates to solve their own problem. At the even higher level of *analysis*, other students recognized patterns and made connections to their own or their peers' solutions. Some forms of *synthesis* and *evaluation*, the highest components in Bloom's hierarchy, were evident when students made predictions from the Web postings and compared their own ideas to others' responses. Overall, the Math Forum format naturally fostered and cemented critical thinking skills.

As I listened to students' informal conversation, I noticed a common complaint: the difficulty of expressing on the blog how they drew a picture as a part of their solution. My students frequently asked me if they could show the picture they drew to explain their solution more thoroughly. For future math blogs, a drawing tool will be helpful so that students have the option of including their doodles and pictures in their strategies.

Math Blogs and My Teaching

Blogs highlighted the importance of allowing students an avenue for intellectual discussion that is primarily student directed. My findings encouraged me to step back and permit my students to share a free flow of ideas and thoughts within the structured environment of a blog. When I facilitate discussions, I am inclined to take control of the dialogue and lead in the direction I want to go. I realized that allowing student-led discussions empowered students to be a community of learners, promoting an intrinsic responsibility for learning and communicating with other learners. In addition, the exchange of ideas was more meaningful to the students because it came from their peers.

Figure 2

Setting up your blog

How to Set up a Blog

- Ask your school's technology specialist for assistance. Find out what programs are available for you to use at school. If your school does not offer the appropriate software, look online. Free Web-based blogging tools are available for educational purposes.

Some Helpful Tips

- No matter what subject you are focusing on, always ask open-ended questions that encourage diversity in responses and thinking.
- Model appropriate online etiquette. Teach students how to post and respond productively. Remind them to be positive and constructive in their comments.
- For safety purposes, require students to use only their initials or their first names.
- Set up your blogs so that all postings must be approved by you or another adult before they can be officially posted. This process ensures a check for appropriate language and grammar. Provide extra one-on-one support for students who need special assistance.

During my preservice teacher training, my professors stressed the importance of *modeling* positive behaviors, methods, and strategies for students. This advice holds true for using technological tools as well. When introducing the blogs, I demonstrated good metacognitive responses and complimented all my students' postings. As a result, my blogging set a positive standard for students to follow. Social learning theory suggests that the development of behavior is highly influenced by modeling or observational learning (Berk 1997). This was undoubtedly true in my online classroom. The students learned from my behavior as well as that of their peers. They learned that positive reinforcement and compliments are desirable and continued to use them throughout the blogs. Teachers are the primary instigators of the classroom climate, even in a virtual classroom.

My students' work affirmed the usefulness of blogs as a tool to encourage verbal interactions and enhance learning. Although blogs are *written* discourse, I believe they were as critical as *spoken* dialogue in the children's development of their knowledge strategies with the mathematics story problems. My students first had to think about their solution strategies and then effectively communicate their steps into words that their peers could comprehend. A current researcher, Azevedo (2005), argues that using computers is successful in varying degrees depending on students' abilities to regulate their own thinking and learning. In essence, such regulation is the metacognitive process that students must use to make blogs a productive learning experience. My students' work through Math Forum supports Azevedo's argument. The blogs led my students to regulate their thinking by reflecting on their solutions, and this, in turn, led to metacognition and enhanced learning.

As the school year progressed, I noticed that some of my students had difficulty listening when others shared orally, especially in whole-group settings. Blogs seem to be the perfect remedy for this problem. Because the blogs require reading for comprehension in order to respond, students must pay careful attention to their peers' ideas. As an extension of Math Forum, blogs can be transferred to any learning context or discipline. Through the use of blogs in other subject areas besides mathematics, I learned that online discussions can be used for multiple purposes when addressing students' academic and social needs.



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Influence of My Research on Future Classroom Endeavors

A lesson I learned is that action research is not strictly about statistics and collecting quantitative data; it is a component of what all excellent teachers do daily. Research is embedded in our practices of trying new strategies and discovering what works well for our learners. My research affirmed the worthwhile strategies I am using already and helped me focus on sharpening the areas that need improvement to meet the needs of all my diverse learners. My exploration of online discussions and blogging this year was only the tip of the iceberg. The study affirmed my instincts about the amazing potential in using technological tools for promoting literacy and all other disciplines. My students benefited from the exchange of ideas and learned to place value on the diversity of thinking that each of them contributed to Math Forum. I am encouraged and excited about continuing to use blogs in mathematics. As an extension to my research, I hope to encourage other teachers to use blogs with their students (see **fig. 2**). It will be interesting to observe how other educators use online discussions and participate in a learning community that shares and collaborates.

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